2 Copies
STOCK

OTS: 60-31,739

JPRS: 3839

6 September 1960

THE MOST IMPORTANT PROBLEM OF BIOLOGY

- USSR -

by S. M. Gershenzon and I. P. Kok

Distributed by:

OFFICE OF TECHNICAL SERVICES
U. S. DEPARTMENT OF COMMERCE
WASHINGTON 25, D. C.
Price: $.50

U. S. JOINT PUBLICATIONS RESEARCH SERVICE
205 EAST 42nd STREET, SUITE 300
NEW YORK 17, N. Y.

F O R E W O R D

This publication was prepared under contract by the UNITED STATES JOINT PUBLICATIONS RESEARCH SERVICE, a federal government organization established to service the translation and research needs of the various government departments.

JPRS: 3839

CSO: 4201-D

THE MOST IMPORTANT PROBLEM OF BIOLOGY

- USSR -

/Following is a translation of an article by S. M. Gershenzon and I. P. Kok in the Russian-language periodical Priroda (Nature), Moscow, No. 5, May 1960, pages 54-56.7

Biosynthesis of nucleic acids with the participation of proteins. Genetic transformation. Ionizing radiations and nucleic acids. Advanced methods of studying the cell.

Research works of recent decades have established the very important role of the nucleic acids and their compounds with proteins (nucleoproteides) in a number of basic biological processes. The work in this direction is developing at exceptionally rapid rates, and therefore an extremely timely event was the convoking of the First Conference on Nucleic Acids and Nucleoproteides, which had the aim of coordinating the research works carried out in various laboratories of the Soviet Union, of discussing their results, and of exchanging experience.

The work of the conference, which was held in Moscow in December 1959, was carried out by more than 400 biochemists, biophysicists, cytologists, geneticists, microbiologists, virusologists, oncologists, and organic chemists from Moscow, Leningrad, Kiev, Tashkent, Sverdlovsk, and Novosibirsk. Fifty-seven papers were read and were accompanied by animated discussions.

It is well known that all organisms, with the exception of certain viruses, contain two different nucleic acids: desoxyribose nucleic acid (DNA), the composition of which includes the carbohydrate desoxyribose and the nitrous bases adenine, guanine (purine), cytosine, and thymine (pyrimidines); and ribose nucleic acid (RNA), the composition of which includes a different carbohydrate, ribose, and the same nitrous bases as the DNA, with the exception of thymine, which is replaced here by uracil. Apparently, both DNA and RNA exist in a tremendous number of forms that are distinguished by the sequence in which hundreds or even thousands of the nitrous bases mentioned above are arranged in the gigantic polymer molecules of these nucleic acids.

Until recent times the conception was rather widespread in foreign scientific literature that DNA molecules possess the ability

of autoreproduction, while retaining their specific chemical structure that was typical of the particular organism. It was hypothesized that the peculiarities of DNA completely determine the nature of the RNA formed in that organism, and the peculiarities of the latter determine just as strictly the characteristics of all the varied proteins typical of the particular organism. Thus, it was assumed that "biological information" (the specific characteristics distinguishing the particular species of living substances from all others) lies only in the DNA and is transmitted from it, via the RNA, to the proteins. This hypothesis concerning the unilateral action of the DNA upon the RNA, and the RNA upon the protein, contradicts the idea that there is a mutual relationship between the processes occurring in the organisms. It leads to the erroneous conclusion that the biosynthesis of DNA does not depend upon the biosynthesis of the other substances of which the organism consists, but primarily upon the most important of them which are protein in nature.

In the most recent time, important discoveries have been made in laboratories that provide factual substantiation for refuting the idea that the biosynthesis of the nucleic acids is independent of the proteins. The paper of S. S. Debov (Moscow) was devoted to the discussion of these discoveries and to a survey of the experimental data on which they are based. The essence of these discoveries lies in proving that the biosynthesis not only of DNA, but also of RNA, is effected through the medium of special ferments, that is, with the direct participation of the proteins. By making use of these ferments which had been isolated from microorganisms, it was possible to reproduce rather completely, outside the organism, the synthesis not only of RNA (S. Ochoa and associates, United States), but also of DNA (A. Kornberg and associates, United States) /See Note/. (Note: Priroda, 1960, No. 1, pages 43-46.)

This same question of the interrelationship of the synthesis of protein and nucleic acids was discussed in the paper of V. S. Tongur (Moscow). The speaker remarked that for the time being it is impossible to give an all-embracing picture of the interaction of proteins and nucleic acids in the process of their synthesis.

However, new data obtained in that field makes it possible even now to confirm that macromolecules of the ferment protein play an immediate role in the synthesis of DNA and RNA. DNA's influence upon protein synthesis is apparently not a direct one, but is through metabolism. In certain instances (tobacco mosaic virus) there has been proof of the direct participation of RNA macromolecules in protein synthesis; on the other hand, instances have been noted when protein synthesis requires the processes of RNA synthesis, but the presence of the polymer molecule of RNA is not obligatory. As regards the link between the biosynthesis of RNA and DNA, the RNA apparently sometimes serves as the predecessor

of the DNA, and sometimes the situation is the reverse. At the same time there is no doubt that the synthesis of RNA may be completely independent of the DNA and its synthesis, so much so that the widespread opinion that the synthesis of RNA is always determined by the DNA is erroneous. The transferral of information during the synthesis of nucleic acids and protein may be either from the nucleic acid to the protein, or from the protein to the nucleic acid.

S. Ye. Manoylov (Leningrad) read a very interesting paper in which he reported that the laboratory that he directs has succeeded in showing that there exists, between the nucleic acids and protein, in addition to a moveable bond through the phosphorus group, an atomic bond. The biological importance of the DNA combined by a simple covalent bond with protein lies in the fact that it is precisely in this form that it carries out its role in transmitting the specific protein from one generation of cells to the next. The facts cited in the paper attest once again to the interrelationship of the nucleic acids and protein in the process of their synthesis.

New data throwing light on the mechanism of the biosynthesis of nucleic acids was also given in the papers read by a number of scientists from Moscow, Sverdlovsk, Novosibirsk, and other cities.

Until recent times, researchers linked the specific peculiarities of various organisms chiefly with various proteins going into their makeup. The works of recent years have shown that among the representatives of various groups of microbes, plants, and animals the nucleic acids are also different. On the other hand, it was discovered that the nucleic acids of various organisms possess a clearly expressed specificity in the sense of their biological activity. Both aspects of the problem--the chemical and the biological--were discussed at the conference.

A thorough analysis of the first aspect of the problem was given in the paper read by A. N. Belozerskiy, Corresponding Member of the Academy of Sciences USSR, which contained a survey of the data in the literature and the results of research works carried out on a large number of species of bacteria and plants in the laboratories that he has directed. Several years ago it was established by the works of the American biochemist E. Chargaff that the molar /See Note/ relationships of the nitrous bases contained in nucleic acids are subordinated to a definite natural law; for example, in DNA the adenine content is equal to the thymine content, and the guanine content is equal to the cytosine content, so that the sum of the purine bases is always equal to the sum of the pyrimidine bases. However, the relationship of the adenine plus thymine (or uracil) to the guanine plus cytosine (or, in abbreviated form, $\frac{A + T}{G + C}$ for DNA or $\frac{A + U}{G + C}$ for RNA) proves, for various organisms, to be extremely varied and characteristic for each of

them, and may be viewed as an index of the specificity of the nucleic acids. (Note: Molarity is the characteristic of concentration of aqueous solutions, expressed by the number of gram-molecules of the dissolved substance in one liter of the solution.)

As ascertained by research carried out by A. N. Belozerskiy and his associates, this index is very similar for the DNA of related species, but differs substantially for the DNA of species that are systematically remote. At the present time there has been a task posed to carry out precise analysis of the specific differences of the nucleic acids of various organisms by determining not only the quantitative relationships of the nitrous bases, but also the order of their disposition in the polymer molecule of nucleic acid.

Research works carried out during the past 15 years on bacteria have revelaed the important role of DNA in the genetic processes occurring in them. Proof was obtained that it is possible for hereditary characteristics of one strain of bacteria (donor) to be transmitted to other strains (recipients) differing with respect to those characteristics, by means of the influence upon them of DNA isolated from the donor strain. This phenomenon, which was given the name "genetic transformation" was, until recent time, known only among microbes. An interesting question now is, can this transformation also occur among multicellular organisms?

In 1957 Zh. Benua (G. Benoit) and a group of associates (France) reported that they had succeeded, by means of administering DNA, in transmitting certain heredity characteristics from one species of ducks to another. In the USSR, Great Britain, and the United States, results were subsequently published of similar experiments which were carried out on rodents and which yielded negative results. New experiments were reported on by O. P. Chepinoga (Kiev) and V. Gashkova (Prague). They both worked on the same object. In O. P. Chepinoga's experiments the administration of DNA isolated from ducks of one breed to ducks of another breed differing in color and a number of other characteristics did not lead to a change in their coloration, although they displayed certain shifts in the chemical composition of the DNA in the direction of the peculiarities characteristic of the DNA donor.

In addition, a considerable number of descendants of the ducks to which the DNA had been administered, had dark spots on the white tail feathers characteristic of the particular breed (the tail feathers of the donor breed were dark). In V. Gashkova's experiments, she was unable to detect any changes in the ducklings to which she had administered DNA isolated from ducks of another breed, although the researcher used the same breeds and the same methods as Benoit. When these papers were being discussed, mention was made of the necessity of continuing these research works.

V. S. Gostev, K. G. Chamova, and D. G. Girgor'yan (Moscow), reported in their papers that nucleic acids and nucleoproteides administered to animals possess, like proteins, but to a weaker degree, the capability of causing the formation of specific antibodies.

Not only in a theoretical regard, but also for practical medicine, a very important problem is the problem of the action of ionizing radiations upon nucleic acids and the nucleoproteides of the cell. This problem was discussed in the paper read by A. M. Kuzin (Moscow), who noted that a change in the submicroscopic structures of the cellular nucleus under the influence of radiation may occur as a result of small shifts in the structure of the DNA macromolecules taking substantial part in the formation of those structures. The violation of the smooth interrelationship of the fermentative processes leads to a profound change in the quality of the synthesized DNA, and the appearance of new DNA molecules causes abnormalities in the structure of the chromosomes.

A rather large number of reports pertained to the cytochemistry of nucleic acids. B. I. Zbarskiy (Moscow) reported on the results that he and his associates obtained with the help of a group of the latest methods used for studying the structures of the component parts of the cell, and their chemical composition (differential centrifuging, electronic microscopy, radioactive isotopes). These methods made it possible to obtain much new and valuable information concerning the localization of DNA and RNA in the cell and concerning the chemical composition of the cellular nuclei not only of normal, but also of cancerous tissues.

Several of the papers read at the conference touched directly upon the changes in nuclein metabolism in cases of malignant growth. The data cited shows that the study of the content and synthesis of nucleic acids in fast-growing tumors not only is important for an understanding of the processes of the conversion of normal tissue into malignant, but also throws light upon over-all problems of the biosynthesis of nucleic acids and proteins.

In the decisions adopted by the conference, mention was made of the necessity of expanding the study of nucleic acids and nucleoproteides and the most rapid overcoming of the lag that still exists in the elaboration of individual questions in that field. It is necessary to devote special attention to the development of research works to study the biosynthesis of nucleic acids and nucleoproteides, their role in genetic processes, malignant growth, and the pathological changes of the organisms in cases of radiation affection.

The participants of the conference unanimously noted the great benefit derived from it and expressed the desire that such conferences be held periodically in the future.

5075

- END -